PERFORMANCE REQUIREMENTS FOR GEOLOGICAL STORAGE OF CO_2

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RESEARCH OBJECTIVES

The probability that long-term geologic storage or sequestration of CO_2 will become an important climate change mitigation strategy depends on a number of factors, namely (1) public acceptance, (2) the cost of geologic storage compared to other climate change mitigation options, and (3) the availability, capacity, and location of suitable sites. Whether or not a site is suitable will be determined by establishing that it can meet a set of performance requirements for safe and effective geologic storage. Establishing effective requirements must start with an evaluation of how much CO_2 might be stored, and how long the CO_2 must remain underground, to meet goals for controlling atmospheric CO_2 concentrations. These requirements then provide a context for addressing the issue of what is an "acceptable" surface seepage rate.

APPROACH

To address the question, "How much CO_2 might be stored underground and for how long?" we developed zeroth-order estimates for the annual amount of CO_2 that would need to be sequestered to meet atmospheric stabilization targets of 350, 450, 550, 650, and 750 ppmv. We assumed geologic sequestration would be used as a bridging technology, allowing for the gradual phase-out of fossil fuels over a period of up to 300 years. We also assumed that geologic storage constitutes the only mitigation outside of the climate-forcing parameters included in the emissions scenarios (e.g., parameters such as the rates of technology and economic development, and the strength of the movement toward global environmental and sustainability ethics.)

To address a second important question, "What would be an acceptable surface seepage rate?" we first calculated the rate at which CO_2 might seep back to the surface and then compared the calculated seepage to the allowable emissions for atmospheric CO_2 stabilization at each of the five targets. We assumed that the amount of seepage would be proportional to the total amount of CO_2 stored underground at any given time.

ACCOMPLISHMENTS

Figure 1 shows the range of projected storage amounts across the potential stabilization targets, which average between 900 and 2,500 GtC, and it includes estimated storage capacity for comparison. For an annual seepage rate of 0.01% or 10^{-4}/year, the maximum annual seepage never exceeds 0.5 GtC/year for any of the projected sequestration scenarios and would ensure that at least 90% remained effectively sequestered after 1,000 years. For comparison, the total estimated worldwide volcanic and magmatic degassing is estimated to be 0.07 to 0.13 GtC/year. Because seepage rates less than 0.01% per year meet several criteria for all scenarios, this may be a reasonable long-term global performance requirement for surface seepage.

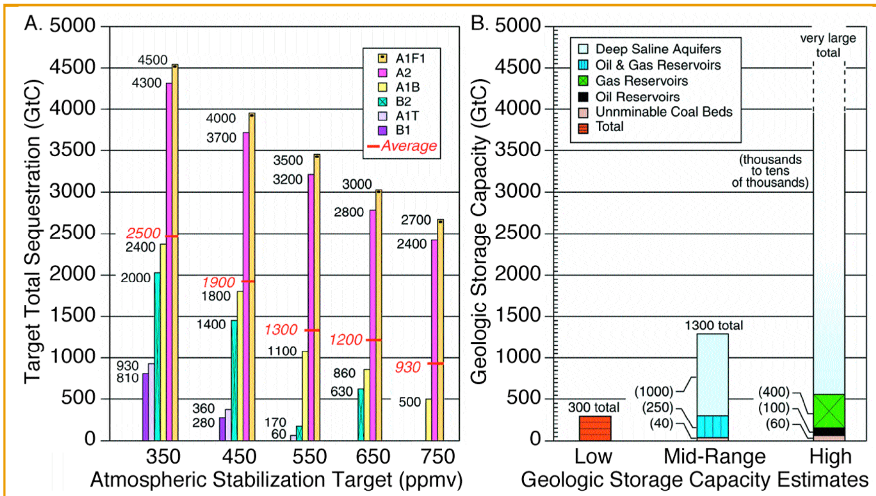

Figure 1. Total target sequestration in Gigatonnes of Carbon (GtC) for each scenario across the range of potential atmospheric stabilization targets in parts per million (ppm) of carbon dioxide.

SIGNIFICANCE OF FINDINGS

According to the results presented here, geologic storage could be an effective method to ease the transition away from a fossil-fuel-based economy over the next several decades to centuries, even if large amounts of CO_2 are stored and some small fraction seeps from storage reservoirs back into the atmosphere.

RELATED PUBLICATIONS

Benson, S.M., R. Hepple, J. Apps, C.-F. Tsang, and M. Lippmann, Lessons learned from natural and industrial analogues for storage of carbon dioxide in deep geological formations. Berkeley Lab Report LBNL-51170, 2002.

Hepple, R.P. and S.M. Benson, Geologic storage of carbon dioxide as a climate change mitigation strategy: performance requirements and the implications of surface seepage. Env. Sci. Tech., 2003 (submitted).

ACKNOWLEDGMENTS

This work was supported by Laboratory Directed Research and Development (LDRD) funding from Berkeley Lab, provided by the Director, Office of Science, of the U.S. Department of Energy under Contract No. DE-AC03-76SF0009.